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Some Applications of Chemistry to Industrial Processes.

Papers read before the Canadian Section of the Society of Chemical Industry during the Session 1912-1913, and published by permission of the Council of the Society. : : : :

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TABLE OF CONTENTS

Introduction

The Canadian section of the Society of Chemical Industry has published under the titles *The Economics of Power Production*, *Some Canadian Industrial Problems*, *Foods*, and *The Chemical Industries of Canada*, collections of papers which have been read at meetings held during the sessions of the section. The Publication Committee of the Society of Chemical Industry in London has been pleased to sanction the issue of this information in pamphlet form.

In the present publication a number of contributions presented during 1912 are collected for the benefit of the members of the section, and also for the use of those who are interested in chemical industry in Canada. While the papers are written by well-known chemists, the language is largely non-technical, and much of the descriptive matter can be followed by the reader who is not familiar with the language of chemistry.

Should it be found desirable to pursue further any subject which has been dealt with in these issues, information may be sought in the *Journal* of the Society, which is supplied free to members.

The Society of Chemical Industry was founded in England in 1881, receiving a Royal Charter from the Crown in 1907, and numbers over 4,200 members. Its chief object is the promotion of those industries in which chemistry plays a part, be it large or small, and consequently manufacturers, engineers and chemists fill its ranks. The *Journal*, which is published fortnightly in London, is the most important periodical on applied chemistry and chemical engineering in the world, and is widely recognized as an invaluable aid to all those whose occupation demands some chemical knowledge. It contains reports *in extenso* or in abstract form of the papers read before general and sectional meetings, with discussions thereupon; also abstracts of all British, Continental and United States

patents on chemical and chemical engineering subjects; fied lists of British applications for patents and "Con Specifications Accepted"; abstracts of articles relating to ap chemistry selected from British and foreign technical jou and transactions of learned societies; and a classified *Report*, giving information on the Board of Trade ret statistics, alterations in tariffs, Customs regulations, laws a ing chemical industries, consular reports, new openings for and new books. The following divisions, under which abstracts are arranged, serve to show what industries are r sented in the Society:

1. General Plant; Machinery.
2a. Fuel; Gas; Mineral Oils and Waxes.
2b. Destructive Distillation; Heating; Lighting.
3. Tar and Tar Products.
4. Coloring Matters and Dyes.
5. Fibres; Textiles; Cellulose; Paper.
6. Bleaching; Dyeing; Printing; Finishing.
7. Acids; Alkalies; Salts; Non-metallic Elements.
8. Glass; Ceramics.
9. Building Materials.
10. Metals; Metallurgy, including Electro-metallurgy.
11. Electro-Chemistry.
12. Fats; Oils; Waxes.
13. Paints; Pigments; Varnishes; Resins.
14. India-Rubber; Gutta-percha.
15. Leather; Bone; Horn; Glue.
16. Soils; Fertilizers.
17. Sugars; Starches; Gums.
18. Fermentation Industries.
19a. Foods.
19b. Water Purification; Sanitation.
20. Organic Products; Medicinal Substances; Essential Oi
21. Photographic Materials and Processes.
22. Explosives; Matches.
23. Analytical Processes.
24. Miscellaneous Abstracts.

The Society of Chemical Industry is interested in almost every branch of manufacturing. It is a matter of everyday remark that chemistry is becoming more and more important in the industrial world, and this Society endeavors to furnish a common meeting ground for the manufacturer, the engineer and the chemist. Many of the papers which appear in its journal are quite readily followed and understood by those who have had no technical training, and no progressive Canadian who is interested in industrial affairs should lose an opportunity of keeping in touch with progress abroad as well as at home.

The Canadian Section extends to all who may be interested an invitation to be present at its meetings, the dates of which may be obtained from the Secretary.

The Chairman and the members of the Canadian Section wish to express their indebtedness to the Ontario Government for a grant toward the expense of publishing this work.

Toronto, December, 1913.

THE CHEMIST IN THE INDUSTRIAL DEVELOPMENT OF CANADA

W. P. Cohoe, M.A.

One often hears the remark made, that as the nineteenth century was characterized by mechanical development, so will the twentieth century be remembered by future generations as an age of scientific development. It has also been said that this century belongs to Canada. With these two statements as premises it easily follows that the part which the chemist will take in the industrial development of this country will be both large and necessary.

New problems are continually arising as industry progresses. In countries where industries have been long established, the chemist is busy effecting economies in production and improvement in method. In many cases the changes brought about have been so revolutionary in character as to render obsolete the methods formerly used. Capital is naturally unwilling to scrap plant unless absolutely driven to it. In many cases therefore in established industries because of heavy capital investments the most modern methods may not be used.

In a new country like Canada, however, which has hardly begun its industrial career, capital may take advantage of the very latest developments. Thus the chemist will be given full scope in which to demonstrate his ability.

This country is also very largely undeveloped. We have only begun in the last few years to realize that the surface even is not fully known. A Cobalt is discovered and a new set of conditions leads to a new series of industries. Such discoveries will in all probability follow in the future quite as often as will be good for us. Each new development will be a fresh opportunity for the scientific direction of industry.

Industry will always be found where energy is available. Ontario, Quebec and British Columbia abound in waterpower.

It is natural therefore to suppose that the future will see in tries springing up in centres where power may be develo Wherever there is industry there we shall find the chemist.

In as much as none of us is likely to fail to appreciate diminishing purchasing value of a dollar, so also must we di our energies to the elimination of waste. The sum of econo waste in this country per day runs into large figures. instance, it was found in a sawmill cutting one hundred twenty-five thousand feet of lumber a day, that nearly hundred tons of wood per day were destroyed. This seems la enough, but even it is small when we consider that this los only the loss in the log, and does not take into considera the total loss on the tree from which the logs were cut.

It is generally conceded that we must eliminate waste. will further be readily conceded that the problem of turn economic waste into profit is essentially a problem for chemist.

I have tried to show in part then wherein the *opportunity* the chemist in Canada consists. There is opportunity in elimination of waste, opportunity in the study of industr already started, opportunity as industries already characteris of older countries take foothold here, and opportunity as material resources of our country become more widely known

Granted the opportunity, our next questions are these: Wh should be the attitude of the industrial chemist, and what is necessary equipment?

Personally I do not feel concerned with the question as whether industrial chemistry is a learned profession. We know that what to-day is a science had its origin in the alch mistic practices of the Middle Ages. Historically the chem has an ancestry in common with the physician and the pharm cist. A doctor is not a doctor because he knows more or le about medicine, nor is a lawyer such because of his knowled of law. Each is a member of his profession when he passes certain examination and pays certain fees. Without meeting the two conditions one is not of the elect. In this sense there is n profession of chemistry. We chemists have no sacred enclosu

from within which we can look out upon the many. In the terms of unionism ours is open shop. Not that it is safe for us as chemists to assume a "holier than thou" position. Quite the contrary. Attempts have been made in the past to erect the walls of an enclosure sacred to chemists, but without success. Possibly this is not an unmitigated evil. Certain restrictions are necessary in certain cases, especially where empiricism is characteristic. Chemistry is, however, an exact science. Its attitude is one of finding by facts. It would hardly be consistent to build for itself a sacred enclosure while preaching a doctrine of judgment by results. Stating the facts, then, we may say that an industrial chemist in Canada to-day is neither helped nor hindered by professional organization. Every chemist has his own reputation to make. Success or failure will follow his efforts in accordance with the way in which he does his work. Sacred enclosures may serve to distinguish the elect from the non-elect, but your strong man, the man who originates things or who does things, is his own distinguishing mark.

Since then the industrial chemist must be judged by the character of his work, we ask again what must his attitude be in view of his opportunities in Canada?

The industrial chemist must be sure of himself. It is useless to begin a problem unless he has a certain sense of power. Unless he feels that he can by the sheer force of his mind backed by his knowledge lay open the secrets of the material world, it is useless to begin. In this world a man who accomplishes things must know his own mind. The man who knows what he wants usually gets it if he goes after it. The man who wants everything in general and works for nothing in particular usually gets what he works for.

As I have tried to point out, we in Canada are the children of opportunity. Without the sense of power to grasp what is offered and the will to choose what we want amid this wealth of opportunity, without this we should resemble children in a candy shop, standing about finger in mouth, unable to choose. The corollary of this is—he who cannot do his own thinking must work for others.

Along with the power of being sure of his own min successful chemist must have strength and continuity o pose to follow out that which he has set himself to accom Many a brilliant mind is wasted in sporadic effort.

Although the strong man should be sure of himself, he ever preserve an open mind for the opinions of others. should be properly weighed by themselves alone rather judged by the source whence they came. Sometimes a work will make a suggestion quite worthy of the head of the fir

The industrial chemist should not also be lacking in tact patience. He is dependent on others in many cases for proper finding out of his facts. He must also depend on ot for the carrying out of his ideas. He must therefore by attitude to others beget a sense of confidence in him which lead to cheerful co-operation. This is most important. G losses have been made, businesses and careers have been ru because scientific men have not had patience and tact in dea with other men.

There is still another part of the chemist's equipment whi have not mentioned. I refer to his equipment of knowled This is a whole subject in itself, and consequently to-nigh shall only touch upon it.

In the first place the chemist must know as much chemis as possible By this I do not mean that he must unduly spec ize. On the contrary his knowledge of chemistry must be broad that if possible he may be able to put himself in tou with the sources of original information in every branch. I him also have a knowledge of the other great branches of phy cal science, and as general an education as is possible witho neglect of the all-important. The industrial chemist shou also be familiar with the principles of the great branches engineering. I do not mean by this that he should spend great deal of time upon them. He should, however, kno enough to realize the connection of his own work with that the branches of engineering with which he will come into con tact later on. The young chemist need not be grounded to much in so-called industrial chemistry. This latter is largel

practice and is continually changing. He may to advantage, however, study the standard methods which are in use in the handling of materials.

The chemist should also be familiar with his own country. He should know Canada, her waterways, her trade routes, her natural resources, her possibilities, her markets. Location is much in the success of an industry. An industry may be ruined by being wrongly placed. It can be located properly only when a general knowledge of conditions has guided its promoters.

So much by way of the attitude and equipment of the industrial chemist. We may next ask what is his function in industrial activity?

To my mind the function of the chemist in industry consists in a scientific control of production.

Occasionally a chemist may develop into a trader and become a powerful executive head. Ordinarily, however, the very nature of his calling prevents this. The scientific control of production is surely a large enough field. It is certainly one which offers many opportunities here in Canada. In many cases the manufacturer himself does not know this. Working under the conditions of a growing market he may not and in many cases does not realize the necessity for scientific control It is then necessary for the young chemist to demonstrate his value. He must shew his employer that a profit is being made on what he, the chemist, costs.

Every manufacturer has occasion from time to time to avail himself of the analytical services of the chemist. In large works a corps of analysts is maintained.

In this humble though necessary field the chemist usually has to prove his worth. Many manufacturers do not employ a staff of their own, but engage the services of firms doing a consulting business.

Just here let me insert two remarks. First, I wish to refer to the excessive competition for business which has led to a scale of prices for analytical work scarcely capable of yielding a profit if the determinations are done with care. Such a state of affairs

is unfortunate. It puts analytical operations in the han the office boy. He will make a mistake once in a while. will be caught some time by the manufacturer who will the generalization that chemists are no use anyway.

The second remark refers to the maintenance of labora where assay work is done by the Ontario Government. Dominion Government will also make a complete fert determination for five dollars.

This is a form of paternalism which may have been nece in the past, but at present to be consistent it would seem the governments in question should maintain a corps of doc lawyers and dentists.

To return then the first duty of the works chemist usually i examination of materials by analytical methods. This is as necessary as bookkeeping even when contracts are let guarantee specification. Just here we have an analogy w may be illuminating. There are those who may consider the chemist is simply an analyst and nothing more. The tion of routine analysis to chemistry is much the same as of bookkeeping to accounting. Neither analysis nor bookkee is of the highest service unless put to the higher uses of cher control or accounting. The chemist must be able to devise most involved methods of analysis. The accountant know how to keep books. A set of analytical records tells in itself, but may be used by the chemist in improving proc and effecting economies of production. A correctly kept s books is a working necessity, but only when taken in hand a skilled accountant can the real state of a business be foun

Routine analytical work must then be used as a means t end. Some chemists never become more than analysts. outlook of such is not hopeful. They are, however, necess Your real chemist is he who sees the process of manufactur a whole, who uses his facts to enable him to effect economie devise new methods, and once in a while to revolutionize a w industry.

The work of the industrial chemist may be divided bro in a threefold manner.

In the first place there is the everyday work of directing production. This is executive and varies in responsibility in accordance with the ability of the chemist to accept responsibility. If he develops an executive ability, more responsibility will be thrust upon him. Finally, he finds himself works manager.

In the second place he will find opportunity to improve existing methods, cutting corners, simplifying methods and generally adding to the efficiency of production.

Thirdly, he will originate new methods and produce new products. This is probably the highest phase of the chemist's profession. In this branch the chemist will need all the experience, knowledge and wisdom gleaned from his past career. He must be able to distinguish fact from theory. Invention consists more in the power to appreciate a need and to supply it from the experience of the past than it does in pure genius.

I shall now, not because of any particular knowledge of the subject, but rather because of the position with which the Canadian section of the Society of Chemical Industry has honored me, attempt to say a few words to those who may contemplate beginning here in Canada a career devoted to industrial chemistry.

Many come to me as they must to others asking if I can direct them to any position here in Canada. Sometimes I can do so, but very often I cannot. It is only the exceptional manufacturer here in Canada who employs a chemist. There is a place for a chemist, however, in nearly every industry of any size. The only trouble is that the owner of the business does not know it. My advice to the young and rising chemist is, first pick the line of industry in which you think you can make a success, then pick your man. After that tell him some definite thing you realize you can accomplish. Tell him you *know*—not guess—you can make good. Be willing to let the results of your work make your place for you. Be willing for your own sake to forget yourself in your work for others. Do not think of what the results mean to you, but what they mean to your employer. Your employer will be watching results. When economies have been effected, then and not until then will come

the reward. Once your work is valuable, then your employer will realize his need of you and will take steps to make your stay pleasant and long.

In conclusion, let us as chemists be proud of our profession. It is one which is not dependent for its results upon chicanery and advertisement. "Good wine needs no bush."

Anxious of the dignity of our calling and the greatness of its future, let us all by our devotion to our daily work, our honesty of purpose, our good fellowship with each other, our freedom from prejudice and desire for truth, endeavor to make the name of chemist one of honor in our country.

MANUFACTURE OF EXPLOSIVES

Leo F. Guttman, Ph.D., A.C.G.I.

Nitroglycerine, the main ingredient of dynamite, is prepared by the action of strong nitric acid on glycerine. It was discovered in 1847 by Professor Sobrero in Italy, who fully recognized its highly explosive properties, and described methods for its preparation. It was not, however, until Alfred Nobel in 1863 showed how to manufacture it on a large scale, and how to minimize its dangerous properties, that nitroglycerine was used in the service of man. In order to render it safe in handling, Nobel dissolved it in various solvents, but finally discovered that the best method was to absorb it in a porous earth called kieselguhr. This consists of the siliceous skeletons of minute diatoms, and possesses the property of absorbing or taking up within itself up to 80 per cent. of its weight of nitroglycerine. This explosive was subsequently replaced by "blasting gelatine" in which Nobel employed soluble nitrated cellulose in place of kieselguhr, and thus obtained a jelly which, while retaining the powerful explosive properties of nitroglycerine, was safe to handle.

Nitroglycerine is now used as a constituent of many explosives, both for blasting and shooting purposes, but the nature of the substances admixed with it varies in the different countries.

Early Manufacture.—The original method of manufacturing nitroglycerine was to run the glycerine into a mixture of nitric and sulphuric acids, which was kept cool in a vessel of water and was continually stirred by hand. In this way up to 100 grams, or a quarter of a pound of glycerine, were nitrated. The nitroglycerine separated as a heavy oil, floating on top of the mixed acids, and was isolated by pouring the contents of the vessel into a large mass of water, whereby it separated out at the bottom. As many as 116 nitrating vessels, with a charge of about 20 lbs. of mixed acids each, were thus employed at one of the earliest

factories in Massachusetts, the nitration lasting from one an
half to two hours. After being separated by pouring into wat
the nitroglycerine was thoroughly washed with successive p
tions of fresh water, and finally with sodium carbonate solut
to remove any traces of alkalinity, and was then stored in ti
When dynamite began to be used on a large scale, this meth
of manufacture proved inadequate, but yet our modern meth
of manufacture are in principle the same as those of forty ye
ago.

It will be best at this place to mention the properties of
various substances employed. Glycerine was formerly thro
away in the waste lyes of soap factories, but is now regard
as a most valuable by-product, and carefully recovered. It
obtained from the lyes as a liquid of 80 per cent. strength
simple evaporation, the economy of the process of course deper
ing on the efficiency of the apparatus employed. The cru
glycerine thus obtained is purified by distillation, and usua
submitted to a second distillation, both being carried out in
vacuum, or under greatly reduced pressure. Thus obtain
glycerine is a clear, heavy liquid, highly refractive, colorless a
odorless, with a sweetish taste to which it owes its name. It h
a specific gravity of over 1.26 and is readily frozen by cold. It
nowadays transported in steel drums, and can be readily kept
months without deterioration. It is very hygroscopic, and wh
rubbed on the skin absorbs moisture from it, causing a stro
burning sensation. There is recorded an interesting case of
workman, who secretly used to drink half a pint of glyceri
a day, the burning feeling in his stomach evidently giving hi
the same experience as if he had drunk brandy.

Sulphuric acid is now a familiar commercial article, a
beyond stating that it is required in a state of purity, needs
further attention. It is best employed as strong as possible,
98 per cent. strength and over. Of late years use has been ma
of sulphuric anhydride, usually called "oleum", the use of whi
presents several advantages as will be shown later.

The nitric acid employed should be as pure as possible, of
specific gravity of 1.504 and over, containing at least abo

96 per cent. of nitric acid or so-called monohydrate. It should be free from chlorine, and should not contain an excess of nitrous acid. This latter ingredient imparts a yellow color, and if amounting to less than 2 per cent. is not objected to by most dynamite factories. In America the practice is to keep the content of nitrous acid as low as possible, usually below .4 per cent. Its presence does not interfere with nitration. Most explosive factories manufacture their own acid, not only for the sake of purity and convenience, but thereby also effecting a large saving in cost. Nitric acid is prepared by the action of strong sulphuric acid on sodium nitrate or Chili saltpetre, the nitric acid gas obtained being led away to a suitable condensing battery. Various systems are in use, all giving a nearly theoretical yield of strong nitric acid. A good nitric acid plant should, however, produce the maximum amount of high grade acid, with the minimum amount of nitrous acid, and weak nitric acid. With a well designed plant, nitric acid of 96 per cent. strength is obtained in quantities constituting over 98 per cent. of the whole acid obtained, and containing but small amounts of nitrous acid. Any weak nitric acid, that is, acid under 90 per cent. strength, obtained in such a plant, is a more or less waste product, being totally unsuitable for the manufacture of nitroglycerine and nitrocellulose.

Manufacture of Nitroglycerine.—This is carried out in large cylindrical leaden tanks, the quantity of glycerine treated in one operation being between 250 and 1,000 lbs. During the nitration of the glycerine, a certain amount of water is produced, according to the following equation,

$$C_3H_5(OH)_3+3HNO_3=C_3H_5(NO_3)_3+3H_2O$$

and this water dilutes the nitric acid used, and stops further nitration. It is therefore usual to nitrate with a mixture of strong sulphuric acid and nitric acid, the mixed acids being so proportioned that the sulphuric acid absorbs and combines with all the water produced in the reaction, and thus keeps the nitric acid up to its full strength. Formerly there were taken for 100 parts of glycerine, 470 parts of sulphuric acid of 98 per cent.

strength and 260 parts of nitric acid of 96 per cent. stre
The advantages obtained by using different mixtures wi
dealt with later.

The nitrating operation is carried out as follows: the char
mixed acids is put into the lead vessel, and kept thorou
cool by means of cold water which circulates in coils of
pipe arranged inside the nitrator. The temperature of
mixed acids is thus brought up to 15° C. The charge of glyc
is now run in from a storage vessel. To avoid undue
heating, which can easily give rise to decomposition and e
sions, the glycerine must be run into the mixture at the bo
and in a fine stream. This is done by letting the glycerine
through a lead coil with numerous fine perforations, place
the bottom of the lead vessel. Glycerine, being lighter than
mixed acids, its specific gravity being 1.26 and that of the a
about 1.75, rises to the top and becomes nitrated. To in
thorough nitration, the whole mass is thoroughly agitated
vigorous current of compressed air, which is blown in thr
a perforated lead coil. During the process considerable he
developed, and the temperature of the mixture rises. It ha
be carefully regulated and must be kept down to about 26
This is accomplished by means of the cooling water, and
regulating the supply of glycerine. Should the temperature
any reason rise to 26° C., the flow of glycerine is stopped,
the full supply of compressed air stirring is turned on. Ni
tion is then not recommenced until the temperature of
mixture has again fallen to about 20° C. The nitrating ve
is provided with a large thermometer, and a trusty workma
placed in charge of this, to watch the process. Should
temperature for any reason rise to between 26° and 30°, wh
represents a danger point, the whole charge has to be drown
This is accomplished by opening a large earthenware cock
the bottom of the vessel, through which the mixture is allo
to flow rapidly into a large vessel filled with cold water, pla
underneath the nitrator, or preferably in a separate shed.
being thus suddenly diluted with a large amount of cold wa
decomposition is stopped, and the mixture rendered harml

This sudden rise in temperature, or decomposition in the nitrator, is usually caused by local heating, where small particles of glycerine come in contact with the acid mixture, and are not immediately thoroughly dispersed. Any trace of local heating of this sort may cause decomposition and possibly explosion of the whole mass. Nitroglycerine, when still impure and in contact with the acid mixture, is exceedingly sensitive and liable to decomposition. Some idea of this may be obtained from the statement that a drop or two of water falling into such a mixture, unless at once stirred, may decompose and explode the whole charge. When all the glycerine has been run in, the charge is allowed to settle.

Such in brief is the principle of nitration. The following is a description of the most modern, and possibly the best of modern apparatus for this purpose, that in use at the Royal Gunpowder Factory at Waltham Abbey in England, the process having been invented by Colonel Sir Frederick L. Nathan, together with Mr. Thompson and Mr. Rintoul.[1] In the figure *N. S.* is the nitrating vessel, or as they call it, the nitrator separator. This is as before a cylindrical tank built of lead, and has a sloping bottom. *C* are the coils of lead pipe through which the cooling water circulates. At the bottom of the nitrator separator is fixed an acid inlet pipe, connected to a vertical pipe leading to the reservoir, and also connected to a branch pipe which can be led either to the waste acid eggs or to the drowning tank. The nitrating vessel is closed by a conical dome, provided with glass inspection windows, and carrying at the top a pipe *J*, provided with an acid lute, which can also be closed by means of a lead cover. Compressed air is led into the tank through suitable stirring coils, as described previously, but not shown in the drawing.

The charge of mixed acids is run through the acid inlet pipe, and enters the bottom of the apparatus. The acid inlet pipe is carried below the level of the apparatus, to prevent any nitroglycerine getting into the pipe through the stirring action. The compressed air is then turned on, and cooling water, or nowa-

1. Jour. Soc. Chem. Ind.

days refrigerated water, having a temperature of about 9
is led through the cooling pipes. When the temperature
cated by the thermometer T has fallen to 15°, an injec
placed through the opening J, and glycerine is blown in
the glycerine tank, by means of compressed air. To pr
clogging or the slow flowing of the glycerine, which, a
temperatures, is a very viscous liquid, the glycerine is ke
a temperature of about 25° C. The glycerine rises throug
mixed acids and is thoroughly nitrated as before. Whe
nitration is finished, the injector is withdrawn. Now com
important improvements in this apparatus. In the old fo
nitrator, the mixture of nitroglycerine and acids was ru
from the bottom through an earthenware cock into a sepa
In this separator the mixture was allowed to stand for a
siderable time, nitroglycerine floating to the top. After s
ation it was carefully drawn off through earthenware c
The mixed acids, which still contain some nitroglycerine
produce a little more on standing, and which in this cond
are highly dangerous, were then led to so-called "after s
ation" houses. In these the mixed acids were allowed to
for periods varying between 4 and 10 days, and any nitr
cerine which had separated out was carefully drawn off.
has always been the most dangerous part in the manufac
decomposition and subsequent explosions often taking
in these "after separation" houses. There was very littl
that could be done, however, because if one attempted to de
pose the nitroglycerine in the acids, say, by suddenly tippi
a small charge of water, this, though certainly effective,
gave rise to explosions. Another source of danger in
operations was the presence of earthenware cocks. The
friction of the key of such a cock in its socket may give r
an explosion, if any nitroglycerine accidentally got caught
cavity. Such explosions have actually taken place. Na
Thompson and Rintoul avoid this by their ingenious arr
ment.

After nitration has been completed, they admit old
acids through the acid inlet pipe. The cock regulating

admittance is placed outside and out of all contact with nitroglycerine. The incoming acid gradually raises the level of the charge in the nitrator separator, and the nitroglycerine rises till it appears in the pipe *J*. It there overflows into the pre-wash tank *P. W*. The addition of waste acids is continued, until the mixed acids themselves rise in the show glass *J*, and the separation of the nitroglycerine can thus be accurately controlled and stopped. When finished, the waste acids are emptied into storage tanks, these again being controlled by an outside cock *X*, which is not in contact with any nitroglycerine. Nathan and Rintoul have therefore succeeded in avoiding the use of all cocks, which are always a latent source of danger. When emptied the nitrator separator is ready for another charge.

In the pre-wash tanks the use of cocks has also been successfully avoided. In the old patterns there had to be two earthenware cocks, one for running off the nitroglycerine and one for running off the wash waters. Compressed air stirring is provided. The Waltham Abbey pre-wash tank is of lead, covered with a fixed lead cover with an opening covered with a small rubber flap. The wash waters are run off through a skimmer of pure rubber in the form of a tube, ending at the top in a rubber funnel provided with a loop handle. This skimmer delivers the wash waters into the so-called labyrinth. When the charge is ready for sending down to the washing house, the rubber running off pipe *Y* of the pre-wash tank is slipped off its plug, and placed on a nozzle connected to the gutter leading to the washing house. The gutter, connecting the pre-wash tank to the washing house tank, passes through the opening, and to prevent freezing of the nitroglycerine during cold weather, is surrounded by an outer jacket heated with warm water. The washing of the nitroglycerine is then completed in the wash house. An important consideration is the softening of the wash water, for if this is not done, an objectionable scale forms in the washing tank. After having been washed, the nitroglycerine is filtered from slime, lead sulphate and other impurities. This is accomplished by running it through two flannel cloths, placed in a frame and packed between with sodium chloride,

which later also retains any water in the nitroglycerine. T
nitroglycerine is drawn off through a rubber tube, and tra
ported in rubber lined canvas bags, or wooden vessels lined w
lead. The salt is periodically removed and washed with wa
to recover any nitroglycerine.

Thus obtained nitroglycerine is a heavy liquid, colorless wh
pure, but often slightly yellowish. Its specific gravity is 1.
and 1.735 when frozen. It is readily soluble in organic solve
such as alcohol, ether, benzene, etc. It has a slightly sweet bu
ing taste and is very poisonous. Swallowing one drop produ
violent headaches, giddiness and faintness. In the course
manufacture and use, it occasionally comes in contact w
the skin, especially with the membranes of the nose and mou
The action of the vapor is just as poisonous, and chiefly affe
highly nervous and very robust people. The chief effect
usually a violent headache, felt at the back of the neck.
course of time one becomes immune to the effects. Antido
are cold compress, fresh air, and drinking black coffee.
freezes at 8° (46° F.) into long whitish crystals, which melt w
great difficulty at 52° F. The nitroglycerine was forme
supposed to undergo spontaneous decomposition, but this
now been shown to be not the case. Nitroglycerine can
heated to more than 212° F. for more than a few hours, with
decomposition. Heating to 180° C., that is, 400° F., will in
tably lead to violent explosions. The safest way to dest
nitroglycerine is to pour it in a thin stream on some sawd
and set fire to it, when it burns off quickly and harmlessly.

Formerly explosives factories were satisfied with a yiel
between 210 and 220 of nitroglycerine per 100 of glycerine.
amount theoretically obtainable is 247. By the use of Nat
& Rintoul's process this yield has been carried to 229 pa
representing a material saving. The balance of 18 parts
nitroglycerine is lost in the mixed acids, as either mono
di-nitroglycerine.

To effect the separation of small particles of nitroglycer
from the mixed acids and wash waters, these are always pa
through a labyrinth. (Drawings of the labyrinth were supp

Waltham Abbey years ago by my father.) The labyrinth consists of a rectangular lead tank, provided with vertical partitions. The vertical partitions are alternately provided with perforations at the top and at the bottom. By being forced to take such a zigzag course, the liquids are effectively compelled to give up any trace of nitroglycerine. This then collects along the bottom of the labyrinth, and flows to the drawing off cock. Any mud separating out, in the various operations, which will of course always contain some nitroglycerine, is saturated with paraffin and burned. Working by their method, Nathan & Rintoul have not been forced to drown a single charge in sixteen years. Formerly the quality of nitroglycerine recovered from the wash water settling tank amounted to $4\frac{1}{2}$ per cent. of the total manufacture. By Nathan & Rintoul's process this was reduced to $1\frac{1}{2}$ per cent.

A further important improvement is in the reduction of the total elevation required in the process.

The waste acids are always denitrated. This is accomplished by passing them down a tower made of volvic lava, enclosed in an iron shell, the tower being filled with hollow balls. A current of steam is blown in at the bottom, and all the nitric acid is decomposed and driven off into a suitable condensing battery, usually consisting of a series of towers filled with hollow balls. The nitric acid is thus recovered in a strength of 40° Be, that is, 66 per cent. nitric acid. The sulphuric acid is recovered as of 60° Be strength, and is water white and clear, as well as free from nitric acid.

Manufacture of Dynamite.—Dynamites are prepared by mixing nitroglycerine with a suitable absorbing material. It was not until Nobel invented the use of kieselguhr, which can absorb up to 80 per cent. of nitroglycerine, and is thereby converted into a reddish plastic mass, that nitroglycerine was successfully employed in blasting. It was obvious that the use of such an inert material, to a certain extent decreased the power of dynamite, and hence patents were taken out for using an active

"dope". This dope usually consists in America of either dust or wood meal, or an active dope of ammonium nitra any other nitrate, such as barium, calcium, etc., can be Whatever dope is used, the dynamite is compressed into sa form and cut off into cartridges. The cartridges are wrapp paper, and rendered water-proof by being dipped in m paraffin. In the form of dummy cartridges nitroglyceri the most powerful blasting explosive known, and on accou its high density it requires but a small bore hole, and is th great demand. The chief dangers attending its use are ex tion, if improperly prepared, for on prolonged storage the n glycerine exudes or sickers out from the absorbent. This place with startling rapidity in contact with moisture. nitroglycerine thus exuding, which may also take place moisture contained in a bore hole, runs away, and this leads to disastrous explosions, when later struck by the of an unsuspecting workman.

To obviate these defects again Alfred Nobel invented gelatine dynamites, or blasting gelatines. Their invention greatly supplanted the use of dynamite in Europe, the la only being used to any extent on this continent. These tine dynamites are quite safe against shock and handling, do not exude nitroglycerine if properly manufactured. The used, being highly active, usually gun cotton or nitrocellu does not detract from the strength of the explosives. Th brief is the process of manufacture.

Cost of Manufacture.—I append a comparison between two nitrating processes. In Nathan & Rintoul's process require a less amount of mixed acids, being enabled to do s employing higher concentration of acid. This they attain using instead of pure sulphuric acid, so-called oleum, tha sulphuric acid containing a certain percentage of anhyd SO_3. This is more expensive but yields a larger productio nitroglycerine. The enormous increase in the price of glyce in late years will probably lead to a more extended use of method.

OLD PROCESS.

1.00 ton glycerine at $500	$500
2.73 tons 93.5 per cent. HNO_3 at $107 a ton	293
4.55 tons 96 per cent. H_2SO_4 at 75c. a 100 lb	68
Yield 2.20 tons of nitroglycerine	$861
Cost per ton	392

NEW PROCESS.

1.00 ton glycerine	$500
2.75 tons HNO_3 91 per cent. at $104	286
$3\frac{1}{3}$ tons H_2SO_4 with 20 per cent. SO_3 at 75c. per 100 lbs.	63
Yield 2.29 tons of nitroglycerine	$849
Cost per ton	371
Difference per ton, $21.	

It must, however, not be overlooked, that in the new process about one ton less waste acid is obtained, which will diminish the saving effect by about $8 a ton. On the other hand, with the new process the same apparatus will hold nearly 20 per cent. larger charges.

Ammonium Nitrate Explosives.—The other class of explosives, which are largely used and hence likely to be of interest, are ammonium nitrate explosives. These consist essentially of ammonium nitrate, mixed with combustible substance. As a mixture one can use either charcoal, in its various forms, such as wood or willow charcoal, or an organic substance usually nitrotoluene or di-nitrobenzene, or other active and explosive substances are used.

The manufacture of ammonium nitrate explosives is exceedingly simple. Nitric acid, obtained by one of the aforementioned processes, is neutralized by ammonia gas, the latter being obtained from ammonia water or gas liquor by suitable distillation. When neutralization is completed the ammonium nitrate is obtained by evaporation and crystallization. When dried

and powdered it is ready for use, and is mixed in the right portions with the active ingredients, and suitably pacl These finished explosives are exceedingly powerful, absolu safe to handle as compared with dynamites, being also unfr able. They are spoiled by moisture, but are not thereby dered dangerous, as is the case with dynamite. If it is wishe destroy them, they are simply thrown away in moist gro or sprinkled with water. They present many advantages dynamites. The main objection to their use, however, lie their low specific gravity. On account of this, to produce same explosive effects, they require a bore hole nearly twic big. The cost of blasting operations in hard rock, being c posed not only of the price of the explosive, but largely of cost of drilling the bore hole, ammonium nitrate explosi cannot at present compete successfully with dynamites. I in fact exceedingly doubtful if any material will ever replace use of nitroglycerine, which possesses great explosive proper in concentrated form. In soft rocks and particularly in c mines, however, the use of ammonium nitrate explosives spreading with great rapidity.

It will depend on the relative costs, as to whether dynami or ammonium nitrate explosives will be used in the future. T price of glycerine has nearly doubled within the last year an steadily going up; in fact, it is safe to say that nearly all av able glycerine has been bought up for some years ahead. If price continues to rise, the disadvantage regarding cost betw these two classes of explosives will tend to disappear. It been calculated that the price of glycerine will have to be doub before ammonium nitrate explosives can compete on an eq basis. A class of dynamites, however, which is already larg used, are the ammonia dynamites, such as monobel. Th is no doubt, therefore, that with the increase in the price glycerine the amount of ammonium nitrate added will be creased, and in this way the balance struck in the relati prices. When pushed to the limit, you will see that this w lead to the use of only ammonium nitrate explosives, that when the price of glycerine has become too high.

It must also not be forgotten that this relative disadvantage depends also on the price of ammonium nitrate. With cheaper methods for its manufacture, the use of ammonium nitrate will constantly increase. This is already the case, and various new processes to cheapen the production may shortly be expected. Some of these processes are based on the manufacture directly from sodium nitrate and ammonium salt. Their success depends on the fact that the cost of nitric acid in the form of sodium nitrate is about two-thirds of that of the nitric acid itself. Processes, therefore, which can effect this manufacture easily, will supplant the preparation of ammonium nitrate from nitric acid and ammonia. A cheapening in the price of nitric acid itself is also being effected, the latter being obtained on an ever-increasing scale from atmospheric nitrogen. Huge plants totaling up to half a million horsepower are already in course of operation. Their main production, of course, is nitro-fertilizer for agricultural purposes. Another saving which may be looked for is in the synthetic production of ammonia, and when this also comes the price of ammonium nitrate will be still further reduced. The tendency in the manufacture of glycerine, on the other hand, is for less and less to be produced.

Safety in Manufacture.—The appalling frequency of accidents in powder works drew attention to the dangers of manufacture, and the various governments of the world looked around for means to regulate conditions. It is to the lasting credit of Sir Vivian Majendie, H.M. Chief Inspector of Explosives, that he, in 1875, created the British Explosives Act, which has since been copied and adapted by nearly all civilized governments. As you know, Canada also is contemplating the adoption of such an Act, and hence some of the considerations for safety may prove not uninteresting.

However safe an explosive is said to be, and however much handling and other risks it may be exposed to without danger, it must not be forgotten that the object of an explosive is to explode. Hence an explosive can never be said to be absolutely safe under *all* possible conditions. In the case of dynamites or nitroglycerine explosives, their chief defects are the liability of

the nitroglycerine to exude in contact with moisture; they ar fairly liable to ignite by friction or percussion, and first anc foremost they are liable to freeze. In this latter condition they are excessively dangerous. Even so-called non-freezabl dynamite will freeze at a temperature below 35° F., and if when in this condition, the frozen dynamite is broken or crushec between the fingers, the friction set up between crystals of th material and part of the liquid nitroglycerine is apt to give ris to an explosion. The advantages of dynamite are that it i plastic and can be easily adapted to the shape of a bore hole In the case of ammonium nitrate explosives they are easier anc safer to manufacture and less dangerous to handle and store likewise they do not freeze and are not readily ignited by fire When ignited no explosion results. Their disadvantages ar that they require a larger detonator, and are not able to adap themselves to the shape of a bore hole.

I will briefly mention some of the accidents which may occu in the manufacture of explosives, and this will show the need fo a rigid system of factory inspection.

All buildings should be adequately protected against lightning although how to do this is a matter of very great difficulty. shall deal with this point again later on. It has happened o several occasions that during the drying or handling of explo sives, electric sparks have set fire to them. This source c danger is ever present in the so-called drying houses for gun cotton, where this material is spread on flat trays, and a curren of warm air is blown over it. The friction of this current of ai generates static electricity, and in time a spark will pass from th powder to the lead walls of the chamber, and cause an explosion Modern drying houses therefore are provided with means fo conducting away the electricity into the ground. Again it ha happened that in reeling strands of cordite on a drum, a frictio of the strands between the workman's fingers causes the latte to become charged with electricity. Since workmen in ex plosives factories wear rubber soled shoes, this electricity coul not leak away. On the workman dipping his hands into th bowl of acetone a long spark passed and ignited the aceton

In consequence, nowadays copper rivets are put through the soles of workmen's shoes, which lead away the electricity into the lead floor. Instances like these could be multiplied.

Another most important consideration is the construction of the explosives buildings. It is usual for explosives buildings or danger buildings to be surrounded by high mounds of earth. The object of this is, that should any building blow up, the debris could only be thrown vertically upwards, and not sideways, into other buildings. If a danger building is made of too solid a construction and the solid debris thrown about, it will readily penetrate other buildings and explode these in their turn. This has therefore led to improvements in construction, one proposal having been to build the walls of a mixture of sand and concrete, in such proportions that on explosion they are pulverized. This is the case in Austria. Until a few years ago all buildings had to be provided with adequate lightning conductors. The difficulty lay in the term "adequate". However frequently lightning conductors are tested, they are apt to go wrong, and they may go wrong within a few hours after having been tested, and in that case become not only useless but a great source of danger. It had therefore become the practice in many countries to require the building to be enclosed in a sort of Faraday cage, *i.e.*, a network of wires was strung on poles above the building. In some other cases the building is made of ferroconcrete, the iron lattice work in the concrete itself forming a sort of Faraday cage. To prevent the roof being penetrated by debris from other buildings, it is made double, so that a piece of debris is unlikely to penetrate the layer of sand in between. The latest construction was published in a paper after my father's death. The ferroconcrete construction of the walls remained the same, but the roof is built of two sets of rafters, covered with expanded metal, wire netting, or such like. On dropping an eighty-pound lead weight from a height of seventy feet on to such a roof, the expanded metal stood the shock beautifully, only one mesh being broken. It is therefore obvious that in case of accident, such a building would be absolutely safe against flying debris. When proposed,

the idea was quite new, and great credit is due to the Germ
Government, who, persuaded by my father, gave permissi
for its adoption on a large scale in the rebuilding of a lar
factory. It has likewise been noticed that the disastrous effe
of the shock of an explosion is usually due to its transmissi
through the ground. To militate against this, the floor of t
building is built over a hollow pit, air holes communicating wi
the outer air. The enclosed air therefore acts as a buffer, a
the shock of the explosion through the ground is arrested.
safeguard his priority, my father took out a patent in Engla
for this construction, but expressly stated in his posthumo
paper that he allowed everybody to use the drawing and co
struction, free of all licence fees, since he deemed it his duty
further anything that would lead to the safety of the workm
engaged in the industry. My brother and I will carry out
wishes.

Testing Galleries. You all know that in nearly every count
there is a list of so-called permitted explosives. These explosiv
have been carefully examined, both chemically and practical
by the explosives advisers. They are tested for stability,
of the best tests being the famous broomstick test, and
safety against fire-damp or gases in mines. This latter is acco
plished by firing a charge of the explosive, equivalent in fo
to 4 oz. of dynamite, from a mortar in a so-called testing galle
These galleries vary in diameter from two feet to seven feet, a
are up to 1,000 ft. long. They are built of steel or iron, and fil
with a mixture of explosive gas or fire-damp in known prop
tions. A certain number of shots are fired, and an explos
which can be fired a certain number of times, without explod
the fire-damp mixture, is considered safe for use in fiery mi
and is licensed. Such a gallery is proposed to be constructed
Canada, that in the United States is located in Pittsburgh.

USE OF PERMITTED EXPLOSIVES

C. J. Coll, Esq.

Acadia Coal Co., Stellarton N.S.

It is claimed that the first explosive used in Canada for the getting of coal was in the mines at Stellarton, Nova Scotia, now the property of the Acadia Coal Company. Records show that powder was in use in the early thirties of the last century, at which time the line of shafts to the Foord Seam, and known as the "Bye Pits", belonged to and were operated by the General Mining Association.

Many claims as to mining matters are made with respect to these old workings—some no doubt true, some otherwise. As to whether the above claim is classed as true or otherwise I am unable to say and have not the time to verify. The Pictou County Miners' motto with respect to mines and mining is "to claim everything and concede nothing—and we must stand together".

It is needless to say that in these modern days of keen competition and high rates of wages some means must (wherever possible) be employed to reduce the cost of production or to maintain present costs as long as possible. Granting that it is difficult to reduce wages when once established, the alternative is left—to increase production per workman. Among means employed are machines and the use of explosives—the latter recognized as a means years ago, as now; the former, of comparatively recent date.

Coming back to the crux of the matter, as intimated in my brief preface, we have had experience with many explosives in our mines, and they all point in the same direction—use no explosive other than a permitted one.

We will not consider black powder, except to point out the results and losses which were attendant on its use in the mines of Pictou County. As far back as 1840 or 1841, a miner in one

of the old Bye Pits was burnt so badly by the ignition of gas in firing a shot (black powder) that he died in a short while. It was a daily occurrence—even in the memory of some of our younger miners—to have feeders of gas ignited at the face by shots. So common was this that wet canvas was provided to beat out the flames after shooting; and in some cases where this failed a small cannon was taken close to the face and a heavy charge set off in order to extinguish by concussion. To many of the fires so started which were not extinguished are due the numerous fires in our mines, which have been giving trouble for years and have caused great loss in property. I feel fairly certain that ninety per cent. of the fires which have occurred in the Stellarton Field were started by blown-out shots and by the use of black powder.

Some years ago, it was decided to introduce "Safety Explosives". In the meantime, discipline was becoming more rigid—mining laws and regulations for the preservation of life and property better, and a marked change was at once apparent. While trouble had been experienced with workmen in introducing the safety explosive, it was only in use a short time until the changed conditions so appealed to them that a change back would have resulted in consternation and a strike.

We were not altogether satisfied with the explosive we had in use, for while there was such a marked change, yet at the same time we would occasionally get reports of powder burning in the hole and of many missed shots, etc. We took the question up vigorously with the powder people, but still had complaints from miners, who were becoming more particular as regards results, both from the standpoint of safety and efficiency.

We then decided to try explosives which were on the permitted list of Great Britain, and after months experimenting with different explosives conducted by experts from several different concerns who were seeking the business, decided upon a certain one which was put in our Albion Mines and Allan Shafts, with the best of results. So far as reports from officials and workmen are concerned, we have had no complaints in regard to this explosive since its introduction.

This statement must be qualified, however, inasmuch as while this is true of the explosive we use as manufactured in England under the "Explosives' Act", it is not true of some which was supplied from Canadian works having the right to manufacture the same brand. While we had every assurance that it was identically the same powder (and personally I think it was as far as composition is concerned), immediately it was put into use complaints from workmen and officials began coming in, although they did not know that a change had been made. I therefore decided, after trying to have the trouble located and affording every opportunity to bring it up to the imported standard, to permit no explosive in our mines other than that manufactured under the "Explosives' Act of Great Britain" and on the "Permitted List". We were led to the conclusion that our workmen were interested in their safety to such an extent that they no longer were willing to take any risk whatever that might lie in the powder they were using—and from every point of view I agree with them.

Shortly after we adopted this explosive, we took up the question of displacing black powder, which was still in use at one of our collieries, where the seam is low, the coal hard and dry and where it was claimed by our miners that no powder other than black powder would give results. As squibs were in use, one miner in each working face and holding a Shotfirer's Certificate under the Mines' Act of Nova Scotia was given an unlocked safety (?) lamp. This was also a condition we were desirous of getting away from. As is usually the case, proper discipline with respect to conditions, aside from shooting, is not possible where black powder is in use. These were all combined in our decision toward the introduction of a permitted explosive. Representatives of the miners were met and assurances given that they would be the gainers by the change, and the prediction made that once they became accustomed to the use of the new explosive they would be the last to consent to a return to black powder. Grumbling assent was given to making a fair trial; and while there were complaints for a week or so they gradually dropped. As a result, within a short time

they could not be induced to go back to black powder. No records were ever kept of results at the other mines, but at this particular mine correct returns are kept monthly. An average for four years is as follows:

Lbs. powder per ton of coal..........	Black Powder, 28% more
Cost per ton of coal..................	Black powder, 42% more
Coal per pound of powder...........	Black powder, 28% less
Difference in cost to miner per ton....	Black powder, 5 c. more

making an average daily gain to the miner in powder of 16 c. per day by the use of the permitted explosive.

It is not within the scope of this paper to go into the question of the ways and means to be adopted for procuring rules and regulations in connection with permitted explosives in Canada or in each province, as the case may be. But I am certain better results would obtain from some sort of supervision over the manufacture of explosives to insure uniformity in quality and to lessen dangers surrounding its use in coal mines.

In many of our mines we are obliged to use explosives in order to "get" our coal economically—this being granted, let us have the best and safest. Personally, I do not think any of them are *safe*, nor do I think makers would claim so. But if there are any means whereby they may be brought up to the same standards as are required in Great Britain and on the continent here in Canada let us have them. If not, then, so far as we are concerned with our fiery, dusty mines, we will obtain our explosive where we are sure the requirements warrant us in the belief that such standards must be maintained.

FINISHING MATERIALS AND THEIR IDENTIFICATION

Alfred Burton

The impregnation of cotton with finishing materials occupies a most important branch ot the finishing of cotton fabrics and yarns, but before going into the details of the art a reasonable knowledge of these materials is a most advantageous, nay, even a requisite, grounding for obtaining a clear insight and understanding of this important practice of the cotton finisher.

These materials may be defined as organic and inorganic substances, either forming the body of the finish and building up the handle of the goods or as additions to the finish to produce some particular quality as it may be required to be imparted thereby.

They may suitably be divided into two classes: those which upon boiling with water form a paste which dresses the outside of the fibre, and those which with water form a viscous solution, which wholly or in part may impregnate the fibre itself. This general classification does not, however, exhaust their number, there being those that are insoluble in water, but are used as additions to the two above classified combinations for the purpose of imparting some essential requirement: such as to render the goods softer and more pliable; to give a greater or lesser lustre, for the purpose of adding weight to the fabric or yarn; or for the prevention of mildew and inflammability; while lastly there comes into consideration the addition of dyestuffs and pigments to maintain the original color.

The most important group is the first one, containing the substances forming pastes of which the different varieties of starches play their individually characteristic rôles. They are obtained in large measure from the vegetable kingdom, chiefly from seeds and tubers, also in the organs of plants containing the seeds of germination. The number of starches

is therefore very great, nevertheless on the other hand, only a comparatively few find universal application. The principal ones of the group are wheat, potato, maize, and rice starches.

The starches of commerce are either tasteless, odorless powders, or irregular, white, easily breakable pieces, insoluble in cold water, alcohol and ether, but swell up in warm water, forming a paste. The temperature at which swelling occurs varies with the different starches, *e.g.*, potato starch at 115 degrees F., and sago at about 150 degrees F. A continuation of the heating causes the starch granules to split up and form with water from a clear to a turbid mass, likened in some respects to a solution more generally described as a paste. The different starches behave in this respect by no means alike, showing the greatest diverseness in their solubility in hot water. Of the best known starches potato starch is the most readily soluble and the resultant paste is nearly transparent. The paste-forming and thickening power is in inverse relation to the solubility, the readily soluble potato starch thickening the least, and maize starch the most; thus maize starch produces the stiffest result as an ingredient in the finishing size and potato starch the softest.

A good starch that is a requisite for finishing purposes should be as free as possible from gluten. Most flours contain besides starch also from six to ten per cent. of gluten, the presence of which causes the flours to give with hot water a paste quite different in its properties from that obtained with the corresponding starches, *e.g.*, wheat and rice flour give a paste much stiffer and ropy, also more readily decomposed and more prone to turn mouldy than the same starches. Both theory and practice have recorded the property of a paste made from potato starch to attract moisture in a comparatively short time after cooling causing a loss in adhesive quality, the cheaper potato starches being therefore suitable for combination with wheat starches, producing under heat a thin flowing paste, which on cooling becomes quite firm and will withstand the action of dilute acids for a considerable time. Rice and maize starch give a clear thin paste, which on cooling becomes gradually thicker and

imparts a stiff finish practically like unto wheat and potato starches.

The different flours are, nevertheless, largely employed not very generally for piece goods but, on the other hand, very frequently for yarns, especially when it is desired to obtain a full handle and add weightening materials. The adhesive properties of the flour serve to bind the mineral weightening substances better with the thickening materials on the one hand and with the fibre on the other. By such means an eight ounce fabric may be guaranteed to contain only four ounces of cotton.

Starches may also be made into pastes in conjunction with soda lye and at the usual temperatures, and may thus be used as a groundwork, along with other finishing materials, to produce a paste which will neither turn sour nor promote mould, and will give as stiff a finish as can be produced with starch pastes. Arrow-root, sago, and tapioca starches are also met with in commerce.

The second group comprises the mucilaginous substances of which the best known is gum arabic, though of very limited usefulness. The by far most important bodies of this group are those starches obtained by the process of roasting, such as dextrine, the most important member, the operation being carried out at varying temperatures from 210 degrees to 280 degrees C. Dextrine comes on the market in various degrees of color from a cream to a dark brown. It is readily soluble in water, giving a syrupy solution of similar color to the quality used, the darker ones of course being only useful for dark colors. The lightest in color is obtained from potato starch. British gum is made from rice or maize starch and is of a gold-brown color, and the darkest in color is from wheat starch.

There are also the so-called soluble starches, or dextrines, made by using weak solutions of the mineral acids during the warming of the starches. The next most important members of this group are the glues and gelatines, both well-known products, which in accordance with their physical characteristics give to the goods a certain body, and in relation to their strength a greater or a lesser degree of stiffness. They are of animal

origin, nitrogenous, and therefore like the glutens inclined to promote mould, and as some grades of glue have not an altogether pleasant odor, care must needs be exercised in their employment as additions to the size. Other members are Tragacanth, Flax-seed, Iceland moss, Caragheen and similar plants forming with water a gelatinous mass, which are useful additions for softening the finish. Other substances used largely for the purpose of softening are soaps, fats, olive oil, castor oil, turkey red oil or sulphated oil, paraffins and glycerine. These substances are not used alone, but merely as additions and it is customary to use a certain amount of chalk or magnesia at the same time that these additions are made. Turkey red oil and glycerine should only be added in very small proportions, owing especially to the hygroscopic nature of the latter, that over additions would impart a clammy feel to the fabric which would be most undesirable.

For the imparting of glaze or lustre, such substances as the waxes are brought into play, generally applied in conjunction with soap or other materials of a softening nature, especially if the goods are ultimately to be lustred or glazed by means of the calendar. Occasionally borax is made use of for the same purpose. To obtain weight and fulness, resort is had to such materials as addition agents, as china-clay, talc, kaolin, chalk, barytes, magnesium chloride and epsom salts.

To prevent mildew the following substances are useful: salicylic acid, boracic acid, phenol, and zinc chlorides and sulphates, which latter at the same time add weight.

Occasionally certain dyes and pigments are made use of to maintain the tone and depth of dyed cloths and prevent a lightening of the color which a heavy colorless size would be inclined to impart, the most important being logwood, turmeric, and ultramarine.

Having now completed a general survey of the materials used and noted their chief characteristics, the examination of finished cloths for the purpose of identifying the materials incorporated in the fabric may be taken up, which from a strict chemical standpoint presents to the finisher a more or less

difficult problem. It is here that the experienced man is of good avail; he will be able to detect if the goods have been stiffened or not; he will further be able to distinguish between goods that have been filled or dressed only on the back; or if the goods have been calendered, mangled or beetled. Having decided these points, a decision is arrived at as to the class of ingredients likely to be found present. By rubbing between the fingers or tearing the cloth rather sharply, it is possible to tell if the fabric has been weighted by mineral substances by the production of considerable dust. The water content may be arrived at by cutting a small piece off the goods in question, of determined dimensions and weight, weighing and drying in the usual dry chamber until the weight becomes constant. The difference in weight is the water content. The knowledge of the amount of water present is only comparatively useful. It gives, however, some idea of the composition of the size, especially as to the starch, which is very hygroscopic even like the fibre itself.

To determine the amount of dressing present, weigh first a piece of the material of similar dimensions to that taken to determine the water content, rub it well between the fingers, beat it, or brush it out well, wash in warm distilled water and dry again until the weight becomes once more constant. The loss in weight represents together the incorporated materials and the moisture. The difference between the total loss and the water content, already obtained by the first test, gives the weight of sizing ingredients employed. To determine approximately the weight of starch present, take a third piece of material of like dimensions to the two previous ones and treat at a temperature of 30 to 40 degrees C. in a diastofor solution for some time, wash in distilled water and weigh as before. Mineral colors, china clay and insoluble soaps are not removed by this means.

For the determination of the soluble ingredients the solution obtained by boiling in distilled water must be further examined. This solution will contain any starch, dextrine, glue, soluble gums and soluble salts, also mineral color, if any, in suspension.

Filter the solution and concentrate a small portion by evaporation. A small drop of iodine solution will give a blue coloration if starch is present; should there be no color reaction, continue the evaporation to further concentration and add two or three times its volume of alcohol and dissolve in hot distilled water. From this solution the presence of glues and gelatines may be detected by precipitation upon the addition of a tannin solution, while on the other hand, gums and dextrines are not. To distinguish between gums and dextrines, recourse is had to the polariscope. Dextrines turn the plane of polarized light to the right and gums to the left. If both are present, test with basic acetate of lead, which at low temperatures separate out gums. If there is no precipitate evaporate down to dryness in a platinum crucible. A black charred residue denotes the presence of a derivative of some plant. Sugar may be detected by the usual Fehling's solution. For the determination of the presence of the soluble salts in the filtrate of the distilled water solution, follow the usual procedure for qualitative analysis. What is left behind on the filter is usually china-clay or sometimes talc. The presence of fats is determined by saponification in a boiling soda solution. The solution is filtered and acidified, the wax soaps precipitate and the fatty soaps and acids rise to the surface. From this examination the practical finisher will have a very good idea of the composition of the finish and be able intelligently to prepare a mixture somewhat similar, the same old rule holding good in this case, that practice makes perfect.

THE SCIENTIFIC ADVANCEMENT OF THE CANNING INDUSTRY

An interesting paper on the subject of the Scientific Advancement of the Canning Industry was presented by Mr. R. T. Mohan, M.Sc., of the Dominion Canners Co., at meeting held at Toronto on January 16th, 1913, a full report of which is to be found in the February 28th (1913) issue of the *Journal of the Society of Chemical Industry*.

It was pointed out that while the preserving of foods in a scientific way was based upon the work of Pasteur, there had been a French process as early as 1795. Between 1819 and 1825 the canning industry was first introduced in America. Glass jars were first used, but a little later on tin cans were substituted, the mechanical production of which has been brought to great perfection in recent years.

In the early stages of the process the highest temperature used was that of boiling water. This was gradually increased by the addition of salt and calcium chloride. It was not, however, until 1874 that the closed retort for cooking with superheated steam was introduced. The industry had long been in practice before any real attempt was made to carry it out on scientific principles. The work of Pasteur had proven that decomposition of organic matter was due to the growth of organisms. In 1895 Russell, of Wisconsin, applied the theories and methods of Pasteur to the solution of problems encountered in canning. Since that time a very large amount of work has been done in the way of making careful studies of the organisms found on fruits and vegetables and in the air, and the methods which could be successfully applied to prevent their doing damage to canned products.

"By this careful study of organisms and the changes brought about by these organisms in different classes of canned foods, two distinct divisions have been made in sterilising. It was found that the spores of spore-bearing organisms are very difficult to kill; in boiling water they could survive for hours, but that 10 to 15 minutes at 240° F. usually killed them; it was

also found that these spores would not develop in media having an acidity above 0.3 per cent. On the other hand, yeasts, moulds and some non-spore bacteria were able to grow in a moderately acid medium, but were easily killed in boiling water. Hence, when any foods of high acidity, such as fruits (and tomatoes), are canned, it is usually in boiling water for varying lengths of time, while the non-acid products (vegetables) receive temperatures above 212° F. in order to kill the spores. This then is the line of division between the use of the open bath (or boiling water) and the retort (or temperatures above that of boiling water)."

In order to prevent possibilities of loss careful and systematic tests upon the canned product are made before shipment from the factory. By placing canned goods in a room maintained at a constant temperature of 98° F. it is found that unkilled organisms will have time to develop in about five days. In case any trouble develops a careful examination of the spoiled cans is made both physically and microscopically, and it is then possible from the behavior of the cans to locate the most of the causes leading to the trouble.

It is shown that by the application of these methods it is possible to differentiate between cases in which the material has spoiled because the original bacteria have not been destroyed in the cooking, and those in which the spoilage is due to a leak permitting the entrance of bacteria from the outside. In special cases an examination of the gases generated in cans of spoiled fruit or vegetables is made, and is used to locate the cause of the spoilage. Some of the methods followed in this line of work are outlined.

Information of an interesting character is given regarding some of the technical points which arise in the industry, a part of which we are able to quote:

"In the canning industry we use certain terms in describing spoiled cans, namely, leaks, hard swells, flat sours, and springers. A leak is one where the food is spoiled by the entrance of organisms through a small hole. Sometimes these holes are visible, especially if due to the faulty capping of the can, but more often

the leak is invisible. By a hard swell is meant a can which is swelled out perfectly tight by the gases evolved in the spoilage, and no amount of pressure will force the can back to normal size and shape. This class represents an advanced stage of spoilage, and when the pressure generated inside becomes sufficient the can bursts at the weakest part, usually on the seam. A hard swell in vegetables is usually foul-smelling, due to the malodorous gases formed in the breaking down of the vegetable matter by the spore-bearing organisms; a hard swell in fruits does not give foul gases, but only the ordinary gases of alcoholic fermentation. Generally speaking, hard swells are the direct result of undertreatment.

"By flat sours are meant cans which, to outward appearances, are perfectly normal, but when opened contain foods which are very sour or bitter. This occurs in corn, peas, beans, pumpkin, tomatoes, etc. They may have gone sour previous to being packed, but this condition is rare. The principal cause is undertreatment; the bacteria bringing about this result are spore-bearing; they generate practically no gas; are anaerobic, and hence live on the carbohydrates, producing lactic acid. They are rather slow to develop, and therefore spoilage may not show for months, but if the incubator test is used the spoilage will develop in about 10 days at 98° F. From the fact that the cans are outwardly of good appearance, this class of spoilage presents great difficulties to the packer. When parts of a pack get into this condition, it is a matter of careful and painstaking work to separate the good from the bad, and even when all care is exercised, the methods used are not entirely satisfactory. One method is to put the cans into boiling water, bottoms up. The expansion of the contents of the cans causes the ends to snap out, and of course, the sour cans snap out first. By frequent cutting out of the cans during the heating, a time is arrived at between the snapping out of the sour cans and of the good ones. Another method is to heat the cans until they all snap out, then cool them, and separate the good cans which snap back first. The success of either method depends largely on the operator, and is only approximately correct, because other factors, such

as variation in filling, exhausting, etc., of the cans affect the separation

"*Discolorization in canned foods.* Much trouble is encountered due to loss of color or development of undesirable colors in fruits and vegetables, and many of these troubles have been accounted for. The color of such fruits as strawberries, raspberries and cherries is very delicate and easily destroyed. It was found that some of this was due to the action of the acid on the tin plate, iron compounds, which darken the fruits, being formed. In other cases the fruits lose their color altogether, and as far as I know, there is no explanation of this, except that the chemical compound constituting the color is destroyed by the heat. Light colored fruits, such as peaches, pears and apples, sometimes turn pinkish or brownish. As this may develop in enamel cans, plain cans, or glass jars the cause must be chemical; the brown color is due to caramelisation of the sugar by overcooking, but what the pink color is due to is unknown; it is probably an early stage of this caramelization."

An outline was given of the special methods and mechanical process followed in canning of peas, which serves as an illustration of the efficiency of modern methods and the care and attention which is given to detail. The following paragraph taken from this section will serve to illustrate these points:

"A most desirable quality in canned peas is to have them open up with a clear liquor. Very frequently the liquor is milky or cloudy.

"Examination of this cloudy liquor shows it to have a high content of starchy material; that is, the starch has passed from the peas to the brine. This may come about by overcooking, which would break the peas; by not properly cooking the peas after heating, which would allow a slow cook to go on; by improper grading, when the smaller peas would be overcooked; by mashing at the filling machines, or overfilling the can, when the expansion would mask the peas. If the peas are not properly blanched to remove the mucilaginous matter, this will cloud the liquor. If there has been any heating (sweating) of the peas previous to canning the liquor may be cloudy, because of the

slime produced by the bacteria, and this slime is very difficult to remove by washing or blanching. A most frequent cause is the canning of over-mature peas, when the starch-content is higher than in young peas. All of these points, however, are dependent more or less on the skill and care of the processor."

The paper is concluded by a description of the various classes of materials used, such as tin plates, solder, fluxes, salt, sugars and water, and the difficulties liable to arise in connection with these materials are outlined. For example, it is shown that water high in lime and magnesia forms insoluble compounds with albumins, thus tending to harden vegetables, and where these waters are encountered a purifying system should be installed.

Under the heading of "waste products" it is shown that considerable advance has been made in this direction. Apple waste, such as the peeling and core, are used for the production of wine or vinegar. It may be turned into apple jelly to be used as the base for compound jams.

The amount of specific information included in this paper is very considerable, and is of interest not only to the technologist but to the general public to whom the use of canned foods has become of so great a service.

MANUFACTURE OF ACETONE

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In giving a short address on this subject it is more my intention to collate the various methods industrially employed than to criticise new methods. Whilst therefore little of what I have to bring before you can be called new, the whole will give a comprehensive view of the present state of the manufacture of acetone.

Uses.– The uses of acetone are various, and its consumption has increased rapidly during the last twenty years. Originally only used as a solvent for varnishes, for the manufacture of iodoform and chloroform, enormous quantities have been used in late years, in the manufacture of smokeless powder, particularly of British Government cordite, and in the manufacture of celluloid. In the last two processes use is made of the property of acetone to dissolve or gelatinize nitro-cellulose. Acetone has to fulfil widely differing requirements regarding its purity, depending on the uses to which it is to be put. Both for celluloid and smokeless powder manufacture the requirements are high. It has to be miscible in all proportions with water, must not show more than 0.005 per cent. of acidity, and 100 c.c. mixed with 1 c.c. of a 0.1 per cent. potassium permanganate solution must retain its pink coloration for thirty minutes. It is further required that at least 80 per cent. should distil over at 59° C. (138° F.) However, the requirements vary somewhat in different countries.

Manufacture.—There are three distinct processes available. (1) The recovery of the acetone contained in crude methyl alcohol or wood spirit. This is done by careful fractional distillation, preceded occasionally by chemical purification, and this process is carried out at a profit.

The products obtained are pure methyl alcohol and acetone. It is, however, an open question whether methyl alcohol thus purified has not lost some of the properties for which it is valued, for the excellent solvent action of ordinary wood alcohol seems to be largely due to the 10 per cent. or so of acetone which it contains.

(2) By dry distillation or calcination of calcium acetate.

(3) Directly from acetic acid.

Manufacture from Calcium Acetate.—This has been carried out for many years in a form of still similar to that employed for the manufacture of acetic acid from calcium acetate and sulphuric acid. The still consists of a large, flat, cast-iron pan fitted with a discharging manhole, and closed by a cast-iron cover provided with a paddle and stirring gear, with manholes for charging, and with pipes for conducting away the vapors. The still is set in a suitable brick furnace, particular attention being paid to uniform heating and even distribution of the fire gases. Calcium acetate when heated breaks up according to the well-known reaction into calcium carbonate and acetone.

$$Ca(CH_3COO)_2 = CaCO_3 + CH_3COCH_3.$$

This decomposition takes place at about 400° C. (720° F.). It is of course inevitable that some of the calcium acetate is exposed to a higher temperature, and in that case superheating and decomposition results. Crude calcium acetate of commerce averages about 80 per cent. of calcium acetate and homologous salts. From this one should obtain theoretically about 30 per cent. of crude acetone. Owing to the above mentioned decompositions, and the decomposing effect of tar and other impurities, and also owing to secondary reactions leading to the formation of gases, a much lower yield is always obtained. In practice the yield of crude acetone lies between 20 and 22 parts per 100 of crude calcium acetate. To minimize this decomposition the stirring gear is provided, and by means of it the particles of calcium acetate are continuously brought over fresh portions of the heated still, and superheating or burning of the material is thus prevented. The chief and perhaps the only

objection to this process lies in the fine comminution of the material. The continual grinding produces an impalpable dust of calcium carbonate, and when the stills are later opened for discharging, excessive inconvenience is caused to the workmen in the adjoining localities by this irritating dust. Care must likewise be taken not to discharge such a still while still hot and filled with acetone vapor, for this latter forms an explosive, inflammable mixture with air. To avoid this danger, it is usual to remove the last traces of acetone vapor from the still by blowing in live steam.

At the beginning of the distillation most of the water still contained in the crude calcium acetate comes over. Then follow acetone and its homologues, and several empyreumatic substances. A great deal of calcium acetate dust is also carried over mechanically. Provision is made to collect this in a so-called dust catcher, *i.e.*, a vertical cylindrical vessel in which this dust is supposed to settle. In spite of this, however, the connecting tubes and condensers are liable to choke up, and special provision has to be made for enabling them to be cleaned. When this is done no danger need be anticipated from a choking up of the tubes during distillation. They can be cleaned quite readily and the danger of having a stoppage in the preparation of such an inflammable material as acetone is avoided.

A modification designed to avoid the inconveniences of this process consists in spreading the calcium acetate in a thin layer on flat trays. A number of these trays are placed one above the other on a carriage, and this is then wheeled into an externally heated furnace or muffle. The crude calcium acetate is thereby only exposed in thin layers and superheating or burning is avoided. No stirring gear being required, the production of dust is cut down to a minimum On the other hand, the efficiency of the heating must obviously be less than in a direct fired still. It is claimed, however, that a slightly higher yield of acetone is obtained which compensates for this loss.

Purification of the Crude Acetone.—This had better be described here, being identical for all the methods of manufacture. The crude acetone contains various homologues and oils, and can

be separated from these by diluting to about 30 per cent. with water. The oils and tarry impurities separate out and can be skimmed off, whilst an aqueous solution of acetone is drawn off at the bottom. This aqueous solution of acetone is then rectified, after having been first neutralized, if necessary, in a rectifying column or still of the usual type. The heads and tails are collected separately, and the middle fraction of pure acetone collected. This is considered to be pure when it stands the permanganate test as above described. Any fractions not complying with this test are added to the next batch for rectification. To still further purify the acetone to meet the requirements of the smokeless powder factories it is usual to re-distil it with the addition of a little sulphuric acid.

Manufacture from Acetic Acid.—If the vapors of acetic acid are passed over a heated alkaline earth carbonate, either calcium or barium or magnesium carbonate, the acetate first formed by the action of the acid is continually split up into acetone, water and carbonate, and the cycle of operations then begins afresh. We have here therefore a case of the catalytic action of carbonates, these being continually regenerated during the process. One or two people have already tried to adopt this process commercially, and the author himself spent several months working at it, only to find at the end of a lengthy period of work, that some French patents had been taken out in the interval. The results of the investigation were however somewhat disappointing. The decomposition of acetic acid, even if concentrated, is by no means quantitative, not more than 50 or 70 per cent. being converted into acetone, the rest passing over unchanged. The dilution of the acetone thus obtained is no bar, since it would in any case have to be diluted later on to remove the oily impurities. What however is a serious consideration is what to do with the dilute acetic acid solution thus obtained. It is the recovery of this for subsequently again working up into acetone which mitigates against the successful use of this process. It is also necessary to utilize the crude pyroligneous acid as obtained in wood distillation, and this contains only about 10 per cent. The great dilution of this acid also somewhat cuts

down the yield. It would still appear possible that by utilizing directly the acetic acid vapors obtained in wood distillation, which suggestion is also one of the claims in the French patent, that a not inconsiderable amount of acetone can still be obtained, the acetic acid passing over unchanged being utilized in the usual way.

Experiments carried out by the author on analogous ketones gave still poorer results. It may be of interest to state that attempts were also made to prepare analogous ketones from the corresponding ethyl esters. As is well known ethyl acetate, for instance, breaks up on heating into ethylene and acetic acid, and it seemed that this could be directly utilized in the production of acetone. Experiments carried out by the author showed that ethyl acetate on being passed over heated calcium oxide, gave an excellent yield of acetone, as well as quantities of ethylene. The author would in fact recommend this method for the laboratory production of ethylene.

SPECIFIC REFRACTION AND ITS APPLICATION TO CHEMICAL INDUSTRY

A. McGill, M.A.

The obvious and natural method of distinguishing between and defining the various substances which we deal with is the direct application of the senses to their inspection and study. We look at them, taste them, feel them, smell them. Take as an example the case of butter and lard. They have much in common. Both are greasy, solid at ordinary temperatures, liquid when warmed; both burn in air when sufficiently heated; both are nutritious foods; they answer much the same purpose in pastry-making; and so on. But careful inspection of typical samples shows many points of difference. Butter is yellow; lard is white. Butter melts at a lower temperature than lard; water separates; the melt is cloudy owing to the presence of floating solid matters; salt separates on the surface if exposed to a dry atmosphere; the watery (lower) layer obtained on melting is decidedly salty in taste. The characteristic taste of butter distinguishes it from lard; the smell is likewise characteristic. On prolonged exposure to air the butter turns rancid; the lard does not, or but slowly. Many solvents (coal oil, ether, etc.) dissolve the lard completely, but leave a residue in the case of butter.

In like manner we may examine the not dissimilar pairs: (1) butter and lard, (2) water and alcohol, (3) alcohol and wood spirit, (4) pure water and dilute solutions, (5) olive oil and cottonseed oil, and (6) normal milk and watered milk. Of course this list might be indefinitely extended. I have chosen these substances because it will be convenient and, I hope, useful to consider them further during the evening.

Consider now, as rapidly as possible, the kind of information and its extent which the unaided senses can give us regarding the above pairs of similar substances.

Our acquaintance with the articles named is sufficient to enable us to recognize the fact that, while normal and typical examples of each are fairly well distinguished, there are many samples to be found whose characters are less well marked, and in whose case it becomes very difficult, if not impossible, to say "this is a sample of the first term; this of the second". We find that many characteristics must be regarded as non-distinctive, either because they are possessed in common or because they pass, by gradual transition, through so large a range of intensity as to afford us no trustworthy evidence. We have, so-called, non-essential characteristics. Thus, butter ought to be yellow; but we know that butter may be nearly white and still be genuine butter. How shall we get at the essential characteristics of each species?

The methods of analytical chemistry here come, naturally, to our aid. I cannot in short space describe the methods by which the chemist approaches the subject; but in the briefest manner possible I shall indicate the lines along which he proceeds. My main reason for treating with brevity this aspect of the question is that the methods of chemistry are only available to the chemist. You will readily see from the little I shall say on this part of the matter, that the chemist must possess an intimate knowledge not only of the nature of the substances he examines, but also of the changes that can be wrought in them by special treatment with chemical reagents, and the nature of the products of such chemical action. A long experience has taught me, that true chemical methods of working have very little value except in the hands of such as make a special study and practice of them. The amateur analytical chemist is more likely to bewilder himself and mislead others than to accomplish any good purpose by his work.

To distinguish between pure butter and pure lard is comparatively simple, but to distinguish between pure butter and adulterated butter by chemical means is scarcely a task the amateur should undertake. The detection of adulterations in fats and oils is surrounded by difficulties of which the amateur has not the faintest conception, nor do the various tables of

empirical "values", which he finds distributed so lavishly through the hand-books on the subject, shed any light on his problem. A. H. Allen in his "Commercial Organic Analysis" says: "Numerous methods of examining butter for foreign fats have been devised, but many are wholly worthless for their intended purpose unless the sophistication be of the gross character now almost obsolete." Among the fats known to be successfully employed in the manufacture of factitious butters are the more fusible portions of mutton- and beef-fat, lard, cottonseed oil, palm oil and cocoanut oil. The detection with confidence of foreign fats in butter may require several difficult estimations. One of the most decisive tests is the determination of the "Reichert Meissl Value". This is a decidedly arbitrary determination, and consists in estimating the amount of volatile fatty acids distilled under certain fixed conditions. Similar difficulties present themselves when he attempts to examine a milk sample.

Distinguishing between watery alcohols or solutions of different strengths is, of course, a very much more simple task, simple gravity determinations accompanied by fractional distillation being usually sufficient. The specific gravity of alcoholic or salt solutions can be found to the third place of decimals by means of a Mohr's specific gravity balance or a hydrometer, or with certainty to the fourth decimal place by a Sprengel-Ostwald pyknometer. The hydrometer is merely a glass tube weighted at one end and provided with a stem carrying a scale at the other. The lower the specific gravity of the liquid, the lower the hydrometer sinks, the S.G. being read off directly on the scale. A good set will contain as many as 18 to 20 instruments; of these possibly 5 will be intended for liquids lighter than water, and the others for liquids heavier than water. Such a set enables one, by proper selection, to make very accurate determination in a few moments. The pyknometer consists of a glass tube to either end of which is attached capillary tubing bearing graduation marks. The whole is bent into a U shape to facilitate suspension from the balance pan-hanger. The apparatus is weighed empty, then with water, and then

with the liquid whose density is to be determined. If possible, the determinations are made at 15.5 to save calculations, owing to the fact that most specific gravity tables have been compiled for 15.5° C. The weight of the liquid divided by the weight of the water gives the specific gravity of the liquid in question. 15.5° C. is equal to 60° F.

Substances with different boiling points can be separated by the method of fractional distillation. As an illustration, let us take a mixture of alcohol and water. Water boils at 100°; alcohol at 78.3°. If 500 c.c. of a mixture of equal volumes of alcohol and water be distilled with the aid of a good fractionating column, and every 100 c.c. of the distillate be caught separately, the first fraction (*a*) will be nearly pure alcohol; the second fraction (*b*), alcohol with a little water; the third (*c*), about half alcohol; the fourth (*d*), nearly all water; and the fifth (*e*), practically pure water. By redistilling (*b*), (*c*) and (*d*), adding the distillate from (*b*) to the distillates from (*c*) and (*d*), and the residue from (*d*) to the residues from (*b*) and (*c*), and by repeating this fractionation several times, it is possible to obtain eventually two liquids with constant boiling points of 78.3° and 100° respectively. It is, however, more usual to interrupt the distillation as soon as the thermometer reaches a certain height than to continue till the distillate attains a certain volume. The number of distillations required depends very largely upon the fractionating column. There are numerous types of this apparatus; its efficiency depends upon the amount of contact brought about between the ascending vapors and the descending condensations. The rod and disc and pear-shaped types are among the best; the greater the number of discs and pears, the more efficient the column. Dephlegmators, in which the condensed vapors collect in little by-passes from which they siphon out, spreading themselves as a thin layer on the walls of the enlargement immediately below, are still more efficient.

Now, to return to methods of observation which do not involve chemical treatment, it is clear that if we could make our senses, our sight, touch, etc., more delicate, we might accomplish much more by them than if employed only as Nature has

equipped them. This is, indeed, the whole meaning of instrumentation. The microscope is an instrument for indefinitely increasing the power of the eye to see, and not only renders visible the invisible, but makes it measurable. The thermometer takes the place of the finger-tip as an indicator of temperature, and not only enables us to recognize temperatures far above and below the limits within which our fingers can serve us, but enables us to register and compare them with an exactitude altogether impossible to the unaided organ. The areometer (hydrometer) in its different forms, not to mention the chemical balance, is a means of vastly increasing the delicacy of the so-called muscular sense; that sense for weight which enables to judge one thing as heavier than another. We have still to devise mechanism to render the senses of smell and taste more acute than Nature has made them; and the sense of hearing has not been made of much use to the student of matter, as yet. Other spheres may be attuned to music, but to earth dwellers, our own is silent, and we must "beat our own music out" when we want music. The crackle of a bar of tin when bent is almost the only application of the auditory nerve that occurs to me in connection with the testing of material.

It is in the matter of sight that the most noteworthy mechanical aids have been devised. Tintometers, colorimeters and nephelometers assist us in detecting and registering differences in color and transparency. The polarimeter (polariscope, saccharimeter) reveals to us the influence of molecular structure upon light waves; the polarizer, in connection with the microscope, becomes a very valuable extension of the power of the eye. The spectroscope is a further extension of our power of vision; and to-night I introduce to you an instrument, the refractometer, which takes advantage of what physicists call "optical density". The refractometer is, in my opinion, destined to become a most useful instrument in the hands of persons who need to identify species of matter such as those pairs of substances I have named. It is already a necessity in every fully equipped laboratory; but on account of its simplicity in use, and the high degree of certainty attaching to its indications, I

think that it is destined to find a place in manufacturing industry along with the thermometer, hydrometer, saccharimeter and a few other scientific instruments of already proven value.

Although the refractometer can be used successfully, after a very few lessons, even by one who knows nothing of the fundamental principles upon which its construction is based, it may still be of interest to you to say a few words in explanation.

When a ray of light strikes the surface of a transparent medium, it either passes into that medium or is reflected from its surface. The angle of incidence determines whether the ray will or will not be reflected. As the angle of incidence increases, a point is reached beyond which all rays are totally reflected. Let us apply this phenomenon to the refractometer. This instrument contains a cell to hold the liquid to be examined, the latter in this way being brought into direct contact with a glass prism of greater density than the liquid and of known refractive index which we will call N. When a ray of light passes from one medium to another, the ratio between the two refractive indices is equal to the ratio between the sine of the angle of incidence and the sine of the angle of refraction. Let us now consider the limiting ray, the ray of grazing incidence, *i.e.*, the last one which can pass from the less dense to the more dense medium, and measure the angle, i, which it makes with the normal when emerging from the latter into the air. We find the refractive index of the less dense medium from the formula $n = \sqrt{N^2 - \sin^2 i}$, where n is the refractive index of the less dense medium, *i.e.*, the liquid under examination. The "specific refractive power" or "refractivity" of the liquid can be found from the formula $\frac{n-1}{d}$ (Gladstone and Dale) or the formula $\frac{n^2-1}{n^2+2} \times \frac{1}{d}$ (Lorentz and Lorenz), where d is the density. The value of these expressions is nearly independent of the temperature. When determining the refractive index, however, the temperature must be kept constant. This is done by causing a stream of warm water of constant temperature to circulate about the cell.

In the earlier Abbé type of instrument two revolving *amici* prisms act as a compensator for achromatizing the critical line of total reflection. Diffused daylight or lamplight may be used, and the refractive index read off directly on the scale, which covers the interval between $n_D = 1.3$ and $n_D = 1.7$. This instrument has been in use since the seventies of the last century.

The improved form of the Abbé refractometer possesses the water-cooling jacket designed to keep the cell at constant temperature.

The Zeiss butyro-refractometer differs from Abbé's in that the critical line of total reflection for butter-fat is achromatised, not by special compensating arrangement, but by the prisms themselves, the dispersion co-existent with the total reflection between glass and substance being exactly compensated by the dispersion due to the surface when the light emerges from the double prism in the direction of the telescope. Accordingly, the critical line appears colorless (achromatised) for butter-fat, whilst all other substances differing from it in refractive and dispersive power cause the critical line to appear more or less blue or red when the dispersion is respectively higher or lower than the butter-fat. Only values corresponding to refractive indices between 1.4220 and 1.4895 can be read on the scale, but this range is quite sufficient to cover the case of butter and lard, and their usual adulterants. Instead of the graduated arc, it is furnished with an arbitrary scale (placed within the body of the telescope) and divided into 100 parts, or so-called degrees. It is easy, by means of the tables accompanying the instrument, to convert these arbitrary degrees into corresponding values of n_D (indices of refraction). With this instrument, natural butter-fat at 25° C. varies between 49.5° and 54.0° (scale divisions), while oleomargarine reads from 58.6° to 66.4° (Wollny). Lard at 25° reads a little lower than beef-fat at the same temperature. Each degree centigrade corresponds to very nearly 0.55 scale divisions. A special thermometer accompanies the instrument, and enables approximate conclusions to be drawn from a rea[illegible], at unknown temperatures.

The Pulfrich refractometer requires monochromatic light; either the yellow *D* line emitted by glowing sodium salts, or the *C* or *F* line of hydrogen obtained by means of a Geissler tube filled with this gas is employed. The instrument is more complicated than the other forms described. The angle of emergence, *i*, of the limiting ray is read on the scale, and the corresponding value of $\sqrt{N^2 - \sin^2 i}$ is found from the table supplied by the makers. Readings should check within 1 in the fourth place of decimals.

The Zeiss immersion refractometer possesses many advantages over other forms of the instrument. It simplifies the examination of volatile or other liquids which cannot remain unaltered on exposure to air; the limiting line is much sharper than when the liquid is enclosed between prisms; and it is particularly well adapted for the examination of aqueous and alcoholic solutions. With the aid of an auxiliary prism, a drop of liquid can be examined. The instrument makes possible an accuracy far greater than that obtainable by other types (about ± 4 in the fifth decimal place). Diffused daylight or lamplight is used. The instrument was introduced in 1899, in which year Dr. Pulfrich gave a demonstration at the University of Jena (*Z. angew. Chem.* 1899, p. 1168). In 1902 Dr. Matthes addressed the German Chemical Society at Eisenach on the same subject, and specially characterized the immersion form of the instrument as adapted to quantitative work. Its forerunner was a refractometer specially constructed for the use of a South Polar expedition, to determine the variation in character of seawater at different places. Since this proved to be insufficiently sensitive, the lower prism was discarded, and the instrument rendered very much more delicate thereby. It was found possible to greatly increase the magnifying power of the telescope, hence to enlarge the apparent intervals between the scale divisions. The scale extends from $-5°$ to $+105°$, corresponding to n_D 1.32539 to n_D 1.36640. The mean value for one scale division is therefore 0.000373 as against 0.000675 for the butyro-refractometer, making the instrument practically twice as easy to read.

I shall not attempt to describe the great volume of research work which has been put on record with this instrument, but merely to mention very briefly a few of the most interesting and important articles which have appeared in technical journals.

Under the direction of Dr. Matthes, Bernhard Wagner, in 1902, at the University of Jena, prepared extended tables, based on original work, for the application of the refractometer to the solutions of many salts, acids, alcohol, beer extract, etc.

Leach and Lythgoe (*J. Amer. Chem. Soc.* 1905, p. 964) have elaborated tables for the interpretation of refraction work on ethyl and methyl alcohols, and mixtures. These tables are greatly more extended than those of B. Wagner, and are based on observations made at 20° instead of 17.5°, a much more convenient temperature for our climate.

Ackermann (*Z. Unters. Nahrungs- u. G.-mittel*, 1907, p. 186) has described at length a new method for obtaining a clear milk serum (heating with chloride of calcium) without filtration.

Baier and Neumann (*Z. Unters. Nahrungs- u. G.-mittel*, 1907, p. 369) describe apparently satisfactory methods (with interpretative tables) for fat, water and milk sugar in milk.

Dr. R. Frank Kamenetsky (*Chem. Zeitung*, 1907, p. 791) presents a long paper upon the use of the immersion refractometer in brewing.

THE CARE, HANDLING AND USE OF EXPLOSIVES

E. W. Monk

Whatever view may be held as to the class or strength of explosives *which should be selected for particular mining and engineering operations*, there can be but one opinion as to the desirability of obtaining a stable and carefully manufactured *compound*, whether in the shape of ordinary *black blasting powder*, or of the strongest *high explosives* ever produced.

Undoubtedly there are to-day on the market many so-called patent explosives, particularly in the potash series, which are neither stable nor practicable, much less safe to handle, and under proper *government supervision* would not be allowed.

Reputable manufacturers should, first, give the selection and treatment of the raw materials the greatest care, and the process of manufacturing the best chemical supervision; second, they should always endeavor to see that their finished product is used for the particular class of work and under the conditions each specific *brand* and *grade* is intended for.

The ideal explosive for use under all conditions—assuming the question of potential energy required in each instance to have been determined by other means—is a *compound* possessed of the following qualities:

1. It should not be too sensitive to concussion or friction, or too susceptible of ignition by, for instance, a chance spark.
2. It should remain unchanged after exposure, for a reasonable time, to the atmosphere.
3. It should be sufficiently water resisting to remain unaffected by immersion in water for at least a fixed period.
4. It should be sufficiently plastic to occupy, under pressure of the tamping rod, the full space in the bore hole.

5. It should possess great strength in small bulk, so that a minimum of cost and labor may be expended in the preparation of the bore holes. As the principal cost of preparing a blast is the drilling of the hole, the theoretical explosive that would be most efficient is one that would combine the maximum strength with the smallest bulk, as this would enable smaller holes to be drilled, and possibly allow a greater space between the bore holes themselves. This applies in a special degree where the rock is very hard, and, obviously, there should be a concentration of energy in other instances proportionate to the class of rock to be blasted.

6. It should be capable of complete detonation and give off the minimum of unpleasant fumes. For regular dynamites, to avoid fumes on firing, the chemical balance of the ingredients has to be modified from the theoretical proportion necessary to obtain the maximum force. It therefore rests with the consumer, if regular dynamites are used, to say whether the question of less fumes, at a sacrifice of more strength, is what is required, or whether the question of strength is the most important. Some mines, poorly ventilated, may prefer sacrificing a little of this strength to get a proportionate reduction in fumes, whilst other mines, well ventilated, prefer the maximum strength. Special explosives are available, embodying both strength and freedom from fumes, but these, as a rule, take the form of gelatinized explosives.

Now, in order to maintain this high standard of production, particularly in nitroglycerine compounds, great care and the best of chemical supervision must be given to the manufacturing end. Where danger would probably originate, on storage of nitroglycerine explosives (outside of the proper chemical balance of ingredients used for the absorbents), is where the nitroglycerine has not been properly treated in the factory to eliminate all traces of acid. In the event of the slightest trace of acid remaining in the nitroglycerine, it would naturally cause decomposition and, subsequently, spontaneous combustion. This

can only be obtained by the most careful supervision of raw materials at the factory, and the proper washing of the nitroglycerine, when made.

Users of explosives should always note particularly whether their dynamite cartridges are "leaking", and, if so, they should notify the Explosives Company without delay. Cartridges should never be stood up on end, but always laid flat.

Care and Handling of Explosives.—Granting that the manufactured article has been handed over to the consumer in a properly manufactured and stable condition, it then remains with him to take care of and handle it according to the rules and instructions published and given out from time to time by reputable manufacturers, who are backed by their chemical experts, practical demonstrators and actual users.

Often it has come to my notice of how the explosives are being abused directly they reach the consumer, and in every way conceivable, from leaving it out in the rain, thawing it by placing it directly in hot water, all of which, *besides being very dangerous*, can never give the proper or best results. It has been proved beyond question that when nitroglycerine explosives are subjected to moisture, the moisture taken on replaces the nitroglycerine contents, with the result that the cartridges "exude" and traces of nitroglycerine are found on the outside. This may cause an explosion when the cartridges are handled or laid in the holes, and has often been the cause of many sad accidents.

If explosives users would only stop and realize the great saving and extra benefits, and the lessening of danger to life and property, *which the proper care and handling on their part means*, much indeed would be gained. The product leaves the mill after being treated just like a little baby, and has been manufactured under the greatest care and supervision that chemical science can give, and on arrival at destination it should be handled carefully, stored in a dry magazine, opened up and thawed according to the proper instructions and system, and, finally, used under the conditions the particular brand and grade is intended for. Whilst not advocating the argument as

the one of greatest importance to be considered, yet from the financial point of the owners of the explosives, it would seem very poor policy to subject an explosive article to possible deterioration through improper handling. I have often noticed that an article costing one-quarter the value of explosives is stored in a proper place and handled under the proper conditions, whilst the explosives may be piled in any place that happens to be handy.

Accidents.—I cannot help but emphasize on the very large and yet, I claim, *avoidable* accidents, which have and still are occurring in the use of explosives, and to appreciate this one has but to stop and realize the number of lives lost annually in all classes of work.

For the purpose of expressing myself I am going to divide them into two classes, *direct accidents* and *indirect accidents.*

Direct Accidents.—These, I am going to claim, are a very large percentage at any rate, *avoidable*, and would not occur were the users to do exactly what they are told, no more, no less, but unfortunately, "there's the rub". Men either get over-confident, or else begin to think they know it all, and invariably do that very little thing which they have been told *not to do*. Perhaps it is in the thawing, and to this very day we find it hard to convince some miners that explosives should never be thawed by direct heat from a fire or stove. Never roast before a hot fire, nor attempt to thaw them in any vessel over a fire, or lean them up against hot brickwork, steam boilers, near the fire by blacksmith forges, much less put them in the stove oven or directly in hot water.

Then, if it is not the *thawing*, they probably "pick" at a missfire to see what it will do, or else, smoking around explosives, dropping a lighted candle in a down-hole, partially loaded, ramming the cartridges in the hole with an iron rod, drilling into or too close to a missed hole. In fact, records show that they will do anything excepting "exactly and only as they are told to do".

Now, in Western Canada a lot of explosives are sold for clearing land, and a good percentage is handled by Chinamen,

and, strange to say, I have yet to hear of a Chinaman being hurt, and why? Simply because he does exactly as he is told, no more, no less, and never undertakes to experiment or improve on the careful results established for the safe and proper carrying out of blasting.

There are many more accidents which can come in this class, and too numerous to mention in this paper, but the following is a fair example. I remember an instance where two teamsters were sent to a magazine to get a load of dynamite, and on their arrival they found the log building swarming with wasps, and decided that the proper way to get rid of them was to smoke them out, so they built a fire in the building with the paper lining from the cases, and which paper was, outside of the paraffin on it, probably more or less saturated with nitroglycerine. Results—one man ran a little faster than the other, and lived just long enough to explain exactly what they had done, but had they both been killed outright, all the theoretical and practical explosives experts in the world would never have guessed the exact truth.

Explosives from reputable manufacturers are to-day so bottled up and cushioned as to make them safe to handle and use, and I claim that the largest percentage of accidents under the above heading can and should be avoided.

Indirect Accidents.—All those accidents which perhaps cannot be attributed to actual carelessness on the part of the workmen. For instance, a mucker striking a stray cartridge with his pick whilst mucking, and which would have found its way there more than likely from what is known as a "cutoff" hole. The only remedy for this is for the miners to watch the ground carefully, and drill their holes further apart, so that one will not "cutoff" the other.

Under this class may also come "asphyxia" and poisoning from deleterious gases, resulting from the explosion or even the handling of the explosive itself. The prevailing trouble in this respect is nearly always from noxious fumes coming from "imperfect explosion". This may be due to a weak detonator or a hole only partially exploded by the concussion of the next

one. In the nitroglycerine compounds the fumes or gases from this partial or imperfect explosion form carbon monoxide, which is a poison. The effects are, first, stimulation and afterwards paralysis of the nervous system, starting with a violent headache, great restlessness, excitement, increased activity of the heart and respiration, tremors and spasms; later, unconsciousness, weakness and paralysis occur, labored respiration, diminishing heartbeat, and finally death.

More dangerous yet are the gases and fumes from an explosive containing nitrobenzole (commonly known as mirbane oil), and cases are on record of death occurring in less than four hours after inhaling these poisonous fumes.

To avoid these partial or imperfect explosions, *take care of your explosives*, and see that they are only used in a perfect condition, *i.e.*, properly thawed, not subjected to different atmospheric conditions, such as unnecessarily thawed and refrozen over and over again, kept away from moisture, and used with a strong detonator, the stronger the better and cheaper in the long run. In all my work I advocate nothing less than a No. 6 detonator, containing 15 grs. of a charge, and the way I figure it out is, what is the cost, the very small extra cost, of the stronger detonator, when compared to, say, misfires and partial or imperfect explosions?

In using safety fuse always put the primer on the top of the charge, because otherwise a chance spark from the inside of the fuse may light the explosive and burn it up before the detonator explodes, causing noxious fumes of the worst kind. Always tamp holes properly with suitable clay or sand, as it saves from ten to twenty per cent. of the efficiency of the explosives and gives a more perfect explosion.

In case of asphyxia fresh air is the first thing necessary, then call a doctor. In my experience I have seen but a few cases act alike. With some, cold applications to the head and hot water to the feet will relieve, whilst with others, stimulants seem to help. Yet, with some poor fellows, there is really nothing you can do without the advice of a doctor. In my own case I get the greatest relief by getting into a steaming bath and

inhaling ammonia, and unless the case is very bad, from one to two days usually sees it over. At all times a doctor should be called on the first serious indications, which are shown by the violent headache, chills and nervousness.

The Use of Explosives.—It is hardly possible within the scope of this paper to mention all the different uses to which explosives can be put, much less discuss the proper use of the different brands and grades for each class of work. Sufficient to say that explosives are being used to-day in all kinds of work, from mining to railroad construction; in the lumber camps, on the farm, clearing land and turning the soil, blasting solid salamanders, moving ice-jams, destroying wrecks, etc.

It is a difficult matter and a somewhat risky task to attempt to give advice to the experienced civil and mining engineer or miner in regard to the grade of explosive he ought to use for a particular rock or coal seam. This must of necessity be more or less left to the good judgment and practical common sense of those actually supervising or doing the work. Experience and practice will tell better than anything else the proper grade to use in each specific formation and the conditions under which each respective explosive will show up to its greatest advantage. Practical mining engineers and miners can tell almost at a glance exactly what is best suited for a certain class of rock and just what to expect from the explosive they have selected. To my mind the secret of successful blasting is in the *proper placing of the bore-holes*, the selection of the right grade of explosive and the proper way of loading the holes. Much has been written on *general rules*, which are fundamental and have proved useful, but the most efficient work in blasting is a matter of experience and good judgment and something which comes to one naturally if he will give this branch of his business the same care and attention as he gives the rest.

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Shaft Sinking.—Thinking that perhaps it may be of interest I am going to briefly refer to one of the many different systems of shaft sinking, and with the assistance of my lantern slides, show what explosives did in this particular piece of work.

This shaft was a four compartment one, consisting of a "man-way" and three "skip-ways". The portion which I had the pleasure of sinking was from the 5th level (393 ft. from the surface) to the 6th level, 125 ft. below. This shaft was exceptionally wet, and most of the time the holes had to be loaded under water. The formation of the rock was very "slippy" and of the hardest kind of dyorite. Fairly good breaking ground, but as tight and tough as the mischief, and owing to the slippy nature of the formation, the holes had to be frequently changed. The full size of the shaft was 8 ft. by 24 ft. and with about a 67° dip. The management decided to sink half the shaft first, that is 8 ft. by 12 ft. and then bench the other 8 ft. by 12 ft. down. In this first portion of the shaft we worked two machines and drilled the holes on the "double V cut" system, all of which I will be glad to explain from the lantern slides. Our holes were drilled to break from 8 ft. to 9 ft. advance per blast and this record was kept right up to the end. It was thought impossible to break more than possibly 6 ft. in that class of rock, but by putting in the system of drill-holes which we did, and using Nobel's Gelignite, an explosive now made in granular form and equal to about 75 per cent. in breaking power, and one of Alfred Nobel's last inventions, we were able to take out "cuts" of not less than 8 ft. It sometimes took 15 hours to drill the 22 holes necessary to break this 8 ft. by 12 ft. ground, the total amount of drilling per blast averaging 203 ft. and made up as follows:

4× 8 ft. holes helping "cuts"	=	32 ft.
6×10 ft. holes main "cut holes"	=	60 ft.
6× 9½ ft. holes "breaking-in holes"	=	57 ft.
6× 9 ft. holes "squaring-up holes"	=	54 ft.
Total		203 ft.

As explained we only ran *two machines* and "set up" the *machine bars* but once for each round drilled, we merely having to slide or swing the machine over for the different holes. Our machine steel ran from the short starters to 12 ft. and we had

no trouble in getting the different lengths of steel to properly follow by adopting the gauges given below:

Starters	Under 3 ft.	2 9/16 bit.
Starters	3 ft.	2 3/8 bit.
2nds	3 ft. to 4 ft.	2 1/16 bit.
3rds	4 ft. to 6 ft.	1 3/4 bit.
4ths	6 ft. to 8 ft.	1 9/16 bit.
5ths	8 ft. to 10 ft.	1 3/8 bit.
6ths	10 ft. to 12 ft.	1 5/16 bit.

A stone *pendice* was left at the bottom of the shaft, and after getting the 6th level station well started, the second portion of the shaft was "benched down" with 9 holes. The muck was hoisted with a "donkey engine" to the 5th level and there dumped into skip No. 2 and hoisted to the surface. No timbering was done until the shaft was completed.

I am not in a position to show here the comparative costs and savings made by the "deep-hole" blasting and the system suggested, but the results, *not only in dollars and cents*, but in time as well (and which was an important factor in this particular case), were very satisfactory to the mining company as well as myself. My reference to this piece of work and my lantern illustrations are more to try and convey to this meeting the particular system of bore-holes drilled to get the best advantage out of the specific brand and grade of explosive used.

This subject is a large one, and I would have been glad to go into it more thoroughly, but have only returned from a long absence, and have had very little time to prepare this paper. I trust, however, that you may derive some benefit from these few remarks and from the collection of articles appertaining to the explosives industry, which I have pleasure in presenting to the Kingston School of Mines in the name of my company. If any questions suggest themselves to you, I will be very pleased to answer them, or if at any future time any member desires advice, I will be very glad to hear from him, as owing to my position of chief practical demonstrator of the company, I am desirous of keeping closely in touch with all who are interested in the care, handllng, and practical use of explosives.

Some applications of chemistry to industrial processes.